Tufts University

Chair, High Energy Search Committee,
Department of Physics,
University at Buffalo, The State University of New York,
Buffalo, NY 14260-1500

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Object: Application for Faculty Position in Experimental High Energy Physics and Research Plan

Dear Prof Baur,

I am applying for the faculty position in Experimental High Energy Physics starting September 2005.
At the present I am a Senior Research Associate at TUFTS University, working for the CDF experiment at Fermilab and the ATLAS experiment at CERN.
Before presenting my research plan, I would like to introduce myself and briefly summarize my past experience.

I started my scientific career as a phenomenologist, working on issues related to fragmentation phenomena in perturbative QCD. After my graduation at University of Pavia, Italy, in 1995, under the supervision of Professor Mario Greco, I joined the CDF experiment as visiting scientist at Lawrence Berkeley Laboratory, with a fellowship from Collegio Ghislieri, Pavia. I worked in the framework of the top analysis, on aspects related to the systematic uncertainties present in the determination of the top mass.

In 1997, I joined the Tufts University CDF group and since then I have been involved in several software projects in two HEP experiment: CDF and ATLAS.

In 1997-98 I worked on a proposal for a data handling system based on an Object Oriented (OO) database (Objectivity/DB) for CDF. A prototype database system was built to transfer Run I CDF data and make them accessible via OO visualization/analysis tools. This experience allowed me to get extensively familiar with C++ and object oriented analysis and design. I kept working on issues related to OO database performances in the framework of the ATLAS offline group and MONARC collaboration at CERN.

In 1999 I was appointed leader of the trigger simulation project at CDF. The CDF experiment has a three level trigger system, two of which (L1/L2) are hardware trigger systems. The trigger simulation is a set of several C++ software simulation/emulation packages for L1/L2; they are used as an offline tool to calculate rates and efficiencies and as an online monitoring tool, during data taking as one of the monitors running in the control room. I wrote the complete software for two of the packages (Calorimeter Trigger and Muon Trigger) and provided the necessary framework - infrastructure, Trigger DB access, et cetera - for other developers (mainly physicists with no software expertise) to write code specific for their system (track trigger and silicon trigger). The project has been successfully completed in time for the beginning of Run II data taking. I am currently responsible for ensuring that all the packages are kept up to date in respect to software development (i.e. software releases), that the executable TRGSim++ is available to all CDF users on a daily basis, and that every change in the hardware is reflected in the emulation software.

In 2001, I started working on a simple ntuple representation of the CDF event information.
CDF adopted ROOT as its data underlying persistency mechanism, however the details of it were hidden under an intermediate layer (EDM or Event Data Model) accessible via Application Modules of AC++, the analysis framework.
Our idea was to allow for a quick translation of the data into a flat ROOT Tree, via a standard set of "ntuplizers" for the various objects contained in the CDF event. This allowed us to be decoupled from the framework for all the type of analysis not requiring the use of reconstruction modules, while at the same time maintaining a one-to-one correspondence with the event content.
eN or evtNtuple is now one of the 3 major analysis tools in CDF, and I am the librarian for it.

From 1998 to 2000, I served as convener of a subgroup of the Exotic Physics group, aimed at defining triggers and datasets for exotic searches at Run II (Exotic Triggers and Datasets).
In the meantime, I carried out a Run I analysis aimed at searching for the supersymmetric partner of the bottom quark, produced from the decay of gluinos, in collaboration with the Padova/INFN CDF group.

In the Fall of 2000, together with Young Kee Kim, Nigel Lockyer and Avi Yagil, I initiated a group aimed at bringing together students and young postdocs to learn the necessary skills for doing analysis in CDF with the Run II data. Indeed, due to long hiatus between run I and run II we were realizing that many young people were unprepared for doing analysis, lacking the ability of putting all the pieces necessary to producing a final result together.
Initially we worked closely with a small group of students and postdocs who were relatively new to CDF. We helped them understand the basic detector configuration and the parameters for calorimeter, tracking, electrons, muons (the group was named Low Level Subjects or LLS).
We then educated each other about Run II software (simulation and reconstruction) and helped the offline group and the operations group providing feedback to them when data or simulation variables did not make sense, recruiting people to be part of simulation/reconstruction group, comparing the Level-3 (online) and production output and exercising the data handling system.
The group grew bigger with over 50 people in the mailing list, as of May 2001. Most of the initial

high P_T physics results produced by CDF originated from this group.

From January 2001 to December 2002 I was convener of the Exotic Physics group itself, at a time where CDF was setting the stage for run II analysis. The Exotic group comprises at least half of the CDF collaboration. Again, given the fact that we were at the beginning of a new phase of data taking, there was the need to focus the effort of the members of the group. Following the experience gained in the LLS group, I decided to create a subgroup of the Exotic group, aimed at bringing together senior physicists and the young students and postdocs already actively involved in producing physics results to exchange information, compare tools and provide feedback to each other.
The VEGY group (so called for Very Exotic Group) produced in March 2003 numerous results that were presented at the Winter Conferences, already superseding the Run I results: limits on new particles searches in the dijet mass spectra, dilepton mass spectra, CHAMPS, Leptoquarks and extra vector bosons.

Finally I became actively involved in physics analysis, working on searches for leptoquarks.
In 2003 I concluded two analyses aimed at searches for first generation LQ and in Summer 2003 Daniel Ryan, a Tufts graduate student, whom I followed in his analysis work on searches for second generation LQ, joined me. Daniel completed his work in 13 months, blessed two analyses and defended his thesis in August 2004.
We are currently writing two PRL's and are in the final process of internal review on the part of the collaboration.
In the last few years I have been supervising several Italian summer students at Fermilab, who in general continued working toward obtaining a degree in particle physics.
At the present time, I'm supervising another Tufts student toward his thesis project.

My scientific path has been quite diversified. I was given the opportunity to move relatively smoothly from my theoretical origins to more technical (software) aspects of an experimental reality like CDF. This gave me the possibility of keeping a unified view of high-energy physics since my expertise goes from the theoretical foundations of physics to technical aspects of a HEP experiment. I'm very interested in transmitting this type of vision to the new generations of students. In the past years I have demonstrated very good leadership skills as well as the ability to work in a team and attract younger people to the field.

I will now describe in details my research plan.

My current research interest is focused on CDF and on longer term on the LHC experiments, in particular ATLAS. I consider these experiments to be the best in the next decade in collider physics and I believe they offer a wide potential for physics discovery for several reasons.
In first place they are hadronic machines and it is an established fact that this kind of machines, given the continuum spectrum of energy available for particle interactions, provide access to the wider spectrum of physics processes. Indeed, I agree with the statement that an e^+e^- Linear Collider should be built after the beginning of LHC to correctly tune its threshold energy to the study of new particles of interests, which hints or evidence will come from LHC. And this brings me to a second reason why I consider TeVatron and LHC experiments the most interesting in the next ten years. They in fact will provide the scientific community with real data and the possibility of doing

physics analysis on a reasonable time frame for this kind of large experiments. Both the TeVatron and LHC have been quite delayed in respect to their original schedule. I see projects like the ILC challenging from the point of view of the R&D but extremely risky in terms of extraction of physics results in a timely fashion.
From the point of view of creating a new HEP group it could be tempting to embark in a large hardware R&D project like the ILC, but I wouldn't commit students and postdocs to a project that will not deliver physics in the next 10-15 years.
It is true that ATLAS and CMS are practically defined in term of their hardware profile, but there will be tremendous activity in commissioning these detectors, especially in the area of trigger, software development and monitoring. I believe that people who participated in commissioning CDF and DZero as young postodocs at that time, would be crucial to perform the same task on LHC, given their recent memory and knowledge. This is unfortunately not the case for those who come from earlier experiments (as early as some of the LEP experiments, as the environment does not have much in common with a hadron machine) or an earlier generation, as many of the current technical aspects of HEP experiments are much more advanced and imply a long learning curve. Having spent the last ten years in CDF, actively participating to its commissioning (and having lots of fun doing it!) I can only see myself naturally proceeding to LHC.

In the framework of a 5-years plan, I would try to have both experiments represented in the high energy physics group. Postdocs and students would be required, at different level, to devote some time to CDF data analysis and work on ATLAS construction and commissioning.

Although the final luminosity that can be reached in Run II has been sizably reduced (with a negative impact on potential of discovering the Higgs boson, for example) , new features of the detector are still very useful for other analysis aimed at searches for new phenomena.
I believe it is important to maintain an active role in a TeVatron experiment in the next two to four years in order to assure that physics results can be extracted from the Run II data and publication in physics journals could be reached. If I were hiring postdocs in my group I would make sure that a fraction of their time (I would say 30%) would be dedicated to physics analysis of CDF data, to make sure that at the end of their appointment they would be able to have physics journal publications.
Students, whose term could be longer (but that in any case I would not extend beyond 4 years after passing their qualifying exam) could devote 1.5 years to CDF data analysis for their thesis and the rest of the time on ATLAS construction and commissioning.
This would apply to students and postdocs hired before the end of 2007.

As a current member of CDF, joining this collaboration could be easily achieved through a visiting appointment via a member institution. In particular I was assured by Prof. Sliwa, head of the Tufts CDF group, that the Tufts group would sponsor members of Buffalo SUNY to become CDF visitors. Visitors at CDF would have of course to satisfy service work requirements, in the form of shifts and contribution to the operations of the detector. This would clearly imply the need for funds mostly for travel to Fermilab and purchase of computing equipment to perform analysis. On the other hand the status of visitor would avoid having to justify to the funding agency a sizeable active role, which at this point in time could be difficult to sustain. If Buffalo SUNY group felt that such a move would be advantageous we could suggest that the group would become responsible for maintenance and improvements to a part of the CDF detector.

As for research topics, I am interested in exploiting the capability of tagging events enriched in heavy flavors at the trigger level (Silicon Vertex Trigger) for searches for third generation exotic particles. Also, given the experience gained with the leptoquark analysis in signatures involving leptons, I'm interested to carry on searches for Supersymmetry in channels involving leptons, jets and missing energy.

While the activity in CDF ensure access to real data and the possibility of producing physics publications in the short term, the LHC experiments are the places where new phenomena can be observed in the mid term future, beyond what it is possible to observe with CDF from now to 2007. In a five years plan (2005-2010) it is then very important, in my opinion, to set the basis of a fruitful participation in one of the two collaborations.
Between 2005 and 2010 ATLAS and CMS will go through final construction and commissioning of the detectors and the first physics results could be published around 2009. With this perspective in mind, I would put students to work full time on LHC starting in 2007 and postdocs starting in 2008.

As a current member of ATLAS, I would propose to join this collaboration. I am already part of the Boston Muon Consortium (recently I became involved in MDT chamber tests and certification using the test beam data of 2004) and I would like to get Buffalo involved in the same effort, in particular in computing and software.
I talked with Jim Shank from Boston University (Project Manager for US ATLAS Physics and Computing) and he gave me a positive outlook on the perspective of joining ATLAS.
I also talked with Stephane Willocq, who recently joined the collaboration with a small group from University of Massachusetts at Amherst and went quite smoothly through the process of being accepted as a new institution. As the type of service work he was proposing to do for ATLAS would be similar to my proposal for Buffalo, he is a good source of advice.

There is a formal procedure to join the collaboration and the Buffalo group would have to go through it. There is a requirement in ATLAS to do some "service work" which was traditionally seen as hardware, but now has been interpreted as also including software.
It is clear that a LOT of work remains to be done before real data can be acquired and reconstructed.
My impression from recent ATLAS meetings is that every single group is crying out for more help. For example there will be large need for manpower in the area of building tools to monitor the detector and to do physics analysis.
I would propose that the SUNY Buffalo group would join the muon collaboration. The muon effort in the US is strong from the hardware viewpoint but needs to be building up from the software viewpoint. There are active groups in Michigan, Seattle and Boston. Given the contacts I already have in Boston it would be easy to, at least initially, maintain ties with this group.
Traveling to Boston would not be a problem. Jim Shank suggested also to join UMass Amherst effort and Stephan Willocq confirmed with me that he would be glad to work with people in the same time zone, sharing common interests and possibly meeting face-to-face often.

There are large areas of software and monitoring which are at the moment understaffed.
It is the right time to invest resources into any of the software aspects there are worthwhile tasks to do now and for a number of years to come. Given the complexity of the Muon Spectrometer, a lot of attention will be required for many years. The Buffalo group can get started in one area and things will grow from there. One example could be the the Endcap Muon Chambers alignment. Since the US has been building endcap muon chambers there are a lot of aspects of muon reconstruction that are relevant and will need work: trigger, calibration, alignment, detector description, reconstruction, etc.
Moreover, between 2005 and 2006 the ATLAS computing TDR and LCG TDR will be produced as well as a "physics readiness report". I would like to have the Buffalo group to participate in the validation of the reconstruction software and contribute actively to its the development. As for postdocs and students working on ATLAS, I would try to station some of them permanently in Geneva. Incidentally, this would help the case for joining the collaboration.

As for physics analysis, my main interest is in looking for the Higgs boson and searches for new phenomena. The exact scope of the physics interest will be of course shaped in the course of the TeVatron Run II, as most of the results obtained by CDF and DZero will be the starting point for LHC analysis strategies. The experience accumulated in CDF will be of course very useful at LHC.

Finally, I'm looking forward to the opportunity of working with undergraduate and graduate students and I hope to be able to share my enthusiasm for physics and actively get them involved in the research topics I'll be working on. Given my diversified background I try to keep a broader view on physics, which is at times challenging as our field is becoming more and more specialized. I hope to transmit this attitude to the younger people working with me.
I feel I can contribute significantly to initiate and expand the scope of your Department with the creation of an experimental HEP group and I'm looking forward to meet with you and the search committee.

With Best Regards,
Simona Rolli

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